Prevalence of use of tobacco and cannabis products among UCSF dental patients with Periodontal Disease: cross sectional assessment

by
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ABSTRACT

Background: The aims of this study are to assess the prevalence of tobacco and cannabis use among adult patients visiting the UCSF Dental Center between January of 2019 and June of 2020, and to compare the periodontal diagnoses between tobacco/cannabis use groups, while accounting for demographic confounding factors, such as age, gender, race, ethnicity, and insurance.

Methods: Data were derived from UCSF Dental Center student, resident, and faculty clinics. The extracted data fit the inclusion criteria, which included individuals age ≥18 that had dental examinations completed between January 2019 to June 2020. Data analysis was performed to ascertain the relationship between use of tobacco (past and present) and/or cannabis products and periodontitis as defined by AAP/CDC definitions. Covariates included age, gender, and insurance status. Univariable and multivariable logistic regression analyses were carried out to evaluate the relationship between exposure (tobacco/cannabis use) and outcome (periodontitis).

Results: Within the patient population of UCSF Dental Center, that met the inclusion criteria, 6.2% of patients were current tobacco users, 12.0% were former tobaccos users, 6.5% were cannabis users, and 2.3% were both tobacco and cannabis users. Modelling with multiple logistic regression revealed that current and former cigarette users had 1.7x and 1.4x, respectively, the odds as never smokers of having periodontitis (adjusted OR = 1.7; 95% CI 1.4-

2.2 and adjusted OR = 1.4; 95% CI 1.2-1.7, respectively). Cannabis users had 1.3x the odds of having periodontitis (adjusted OR = 1.3; 95% CI 1.0-1.5). The odds of having periodontal disease while using both cannabis and tobacco product were statistically significant (adjusted OR = 1.7; 95% CI 1.2-2.4).

In addition to looking at the association between tobacco and/or cannabis product use and periodontal disease that included moderate disease, a logistic regression analysis was completed to assess whether there was an association between tobacco products, cannabis products, and tobacco and cannabis products and specifically severe periodontal disease. Compared to tobacco and cannabis non-use, current and former cigarette use was associated with 2.2x and 1.5x, respectively, the odds of a severe form of periodontal disease (adjusted OR = 2.2; 95% CI 1.9-2.7 and adjusted OR = 1.5; 95% CI 1.3-1.7, respectively). Cannabis use did not have a statistically significant association with severe periodontal disease (adjusted OR = 1.1; 95% CI 0.9-1.4). Using both cannabis and tobacco products was associated with approximately twice the odds of severe periodontal disease (adjusted OR = 2.4; 95% CI 1.7-3.2).

Finally, an ordered logistic regression analysis was conducted. This analysis revealed that odds of being in a more severe category of periodontal disease increases with use of tobacco or cannabis products. After adjusting for covariates, current and former cigarette users had 2x greater odds of being in a more severe category of periodontal disease than never smokers (adjusted OR = 2.1; 95% CI 1.8-2.4 and adjusted OR = 1.5; 95% CI 1.3-1.7, respectively). Cannabis users had 1.2x greater odds than never smokers of being a more severe category of periodontal disease (adjusted OR = 1.2; 95% CI 1.1-1.4) Using both cannabis and tobacco

products was also statistically significantly associated with higher odds of being at a greater severity level of periodontal disease (adjusted OR = 2.1; 95% CI 1.6-2.7).

Conclusion: In this sample of dental patients in a Northern California academic practice tobacco use, with and without cannabis use, was associated with periodontitis and severe periodontitis. In addition, the results of this study showed that cannabis use alone was associated with periodontitis, but not severe periodontal disease.

With the recent legalization of medical and recreational cannabis use, there will likely be an increase in prevalence of cannabis use throughout the United States. It is important for health care clinicians to understand its potentials risks. Determining whether an association exists between cannabis and periodontal disease should be a priority for periodontal epidemiological studies. Dental and medical practitioners should take steps to raise awareness of the possibility of regular tobacco and cannabis use as potential risk factors for periodontal disease.

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BACKGROUND

Cigarette smoking is a well-known risk factor for several oral diseases. Smoking has been correlated with increased risk for oral candidiasis, smoker's palate, smoker's melanosis, hairy tongue, leukoplakia, pre-neoplasia and cancers of the oropharynx, and periodontal disease.[1] Periodontal disease refers to a wide spectrum of diseases ranging from gingivitis (inflammation of the gums) to periodontitis (destruction of tooth supporting structures and possible tooth loss). Periodontitis is the most common chronic inflammatory disease, affecting nearly half the adults aged 30 and up in the United States.[2] It results from an interplay between two factors: microbial plaque and the host response. Tobacco use can modify both factors, with smokers presenting more aggressive species of bacteria in plaque and an impaired immune response.[3] Second to bacterial plaque, smoking is the strongest modifiable risk factor for periodontal disease.[4]

CDC data from the 2019 National Health Interview Survey reported that 50.6 million people in the United States were using a tobacco product and 18.6% of these individuals used more than two tobacco products.[5] The prevalence of use was highest in males (26.2%) compared to females (15.7%).[5] Prevalence was higher in adults younger than 65 years old, who were non-Hispanic American Indian and Alaska native, of low educational attainment (high school degree or GED), and who's insurance status was uninsured or had Medicaid.[5] The tobacco product with the highest number of users was e-cigarettes, making up 24.5% of individuals age 18-24 and 49.3% of individuals ages 15-44.[5]

Bacteria are the primary etiologic factor in periodontal disease and studies have shown that smokers have higher proportions of periodontal pathogens compared to non-smokers.

Greater numbers of *Aggregatibacter actinomycetemcomitans, Bacteroides forsythus*, and *Porphyromonas. gingivalis* have been seen in smokers and significantly greater number of *B. forsythus* has been seen with increasing number of cigarettes smoked per day.[6] Moreover, the prevalence of the periodontal pathogens remained high in smokers even after periodontal treatment was performed regardless of the treatment modality.[7]

Smoking also affects both the innate and adaptive host responses by decreasing the levels of salivary IgA and serum IgG and impairing chemotaxis and phagocytosis of neutrophils.[8] In addition, pro-inflammatory mediators, such as TNF-α and IL-8 are elevated in the gingival crevicular fluid of smokers compared to nonsmokers. There is also an increased secretion of inflammatory mediators MMP1 and VEGF, decreased levels of IL-10, and induced cytochrome P450 activity.[4]

Cigarette smoke contains toxic substances that have a direct effect on the periodontium and the healing process. Carbon monoxide in cigarette smoke has been associated with reducing the oxygenation of healing tissues.[9] Nicotine effects the functionality of leukocytes and macrophages. Locally, nicotine binds to the root surface, thereby inhibiting fibroblast attachment and collagen production and increasing fibroblast collagenase activity.[10] In addition to affecting collagenase activity, nicotine has a vasoconstrictive effect on the end arterial vessels of the gingiva.[11] By decreasing the gingival blood flow, nicotine can prevent the delivery of oxygen, inflammatory cells, and nutrients to the end organ, which in this case is the gingiva, thereby resulting in an unfavorable tissue response to disease. The proposed mechanisms for the negative effects of smoking on the periodontal tissues include decreased immunoglobulin G2 production[12], chronic reduction in blood flow and vascularity[13], increased prevalence of

potential periodontal pathogens[6,14], shift in PMN function towards destructive activities[15], negative effects on cytokine and growth factor production[16], and inhibition of fibroblast growth[17], attachment, and collagen production.

There is a gene-environment interaction leading to increased susceptibility to periodontal disease that is heightened when patients are exposed to smoking. In Caucasian populations, IL-1 is considered a strong predictor of periodontal disease in non-smokers.[18] The prevalence of severe periodontal disease was associated with the IL-1α gene polymorphism and IL-1β gene.[18] Meisel 2004 found a gene-environmental interaction with Il-1 and smoking.[19] Subjects with a specific IL-1 gene polymorphism had an enhanced smoking-associated periodontitis risk (OR 4.50) compared to individuals that were found to be genotype negative (OR 0.98).[19] In addition, cigarette smoking increases RAGE expression; RAGE is the receptor for advanced glycation end products. sRAGE is a soluble form of RAGE that is found circulating in the plasma. It is associated with reducing RAGE activation and is pro-inflammatory.[20] Serum levels of sRAGE were elevated in smokers compared to nonsmokers and there was a strong correlation between sRAGE and the number of cigarettes smoked per day.[20]

The quantity and duration of smoking also has a direct correlation with the severity of periodontal disease. Tomar and Asma found a dose response relationship between cigarettes smoked per day and increased odds for periodontal disease. Heavy smokers (≥31 cigarettes/day) had higher risk of developing periodontitis than light smokers (≤9 cigarettes/day) with odds ratios of 5.88 and 2.79 respectively.[21] Former smokers were shown to have declined odds ratios of having periodontitis with increasing years since quitting and the

risk of former smokers in having periodontitis was not significantly different compared to non-smokers after quitting smoking for ≥11 years.[21]

In the absence of treatment, periodontitis results in tooth loss and its associated disabilities, such as inability to chew, impaired speech, and reduced quality of life. In North America, productivity losses due to untreated severe periodontitis and severe tooth loss amounts to $10.48 billion and $16.66 billion, respectively. Tobacco use in general, and smoking in particular, leads to adverse periodontal treatment outcomes. A large body of published evidence reports the adverse effects of tobacco use on the clinical response to the full range of non-invasive and surgical approaches to periodontal treatment. These include non-surgical debridement, open flap surgical debridement, bone grafts, guided tissue regeneration, implant placement, implant survival in sites treated by bone augmentation procedures and periodontal plastic surgery. According to Preber and Bergstrom, smokers had less reduction in probing after nonsurgical therapy, such as scaling and rooting planing.[22,23] They also saw that after modified Widman surgical therapy, pocket reduction was significantly less than in nonsmokers.[24] Kaldahl found that past smokers and non-smokers responded more favorably to periodontal therapy compared to current smokers . Tonetti investigated the effect of cigarette smoke on the success of GTR therapy and found that non-smokers had significantly more CAL gain, 5.2mm, compared to smokers, 2.1mm.[26] Rosen studied the effect of smoking on GTR with DFDBA and found that nonsmokers had better long term treatment outcomes with greater CAL gain in nonsmokers, 42.5%, compared to smokers, 29.2%, after 1 year. [27] Smoking also has a detrimental effect on implant success. According to Strietzel, smokers had a higher risk of implant failure with

simultaneous ridge augmentation, OR 3.61, and without augmentation, OR 2.25, compared to nonsmokers.[28]

Epidemiological data from the Third National Health and Nutrition Examination Survey (NHANES III) revealed that current smokers were 4x more susceptible to periodontal disease compared to nonsmokers and about 41.9% of periodontitis prevalence is attributable to cigarette smoking.[21] The odds of severe attachment loss were greater in smokers compared to non-smokers and it ranged from 2.05 for light smokers to 4.75 for heavy smokers.[29]

Although the prevalence of cigarette smoking has decreased over the past few decades, the prevalence of smokeless tobacco use has remained the same or decreased, and the prevalence of use of other products, e-cigarettes has increased. According to the National Health Survey on Drug Use and Health 2019 among current cigarette smokers, the percentage who smoked cigarettes daily declined from 63.4% in 2002 (or 38.7 million people) to 58.4% (or 26.8 million people) in 2019.[30] In 2015 smokeless tobacco use was at 1.5% while in 2019 smokeless tobacco use decreased but an insignificant amount to 1%.[30] E-cigarette use increased across the board among younger adults, with never smokers and near-term quitters seeing the most significant increases (1.3%–3.3% and 9.1%–19.2%, respectively).[31]

E-cigarettes have been proposed as less dangerous alternatives to traditional cigarette use; however, these nicotine containing products potentially have harmful effects on both oral and systemic health.[32] E-cigarettes produce an aerosol that contains nicotine. They also contain products, such as flavoring agents like diacetyl, that have been linked to various lung diseases.[32] E-cigarettes come in different forms that are made to look like cigarettes, cigars, pipes, pens, and USB sticks. E-cigarettes can also be used to deliver other drugs such as marijuana. Due to

their size and ease of use in a discrete manner, e-cigarettes have become very popular amongst teenagers and young adults. In 2020 the CDC found that 19.6% of high school students and 4.8% of the adult population use e-cigarettes.[33] Among adult e-cigarette users, the percentage of e-cigarette users who never smoked traditional cigarettes was highest amongst the 18 to 24-year-olds (56%).[5]

A traditional cigarette contains about 24mg of nicotine, while e-cigarettes contain anywhere from 6-48mg/ml.[34] 1 nicotine cartridge, specifically in the product JUUL, results in about 200 puffs which is equivalent to 1 to 3 packs of cigarettes.[35] There is very limited evidence for the effect of e-cigarette use on periodontal health. A recent study by Pushalker found that the prevalence of *Porphyromonas* and *Veillonella* was higher among patients who used e-cigarettes.[36] Exposure to e-cigarette smoke shifted the oral microbiome to one of dysbiosis influencing the inflammatory response and susceptibility of cells to bacterial infection. According to Atuegwu, everyday use of electronic nicotine products for a year or more increased the odds of periodontal disease, OR 1.76, even when controlling for other risk factors.[37] Oral epithelial cells are the first to come in contact with vaporized agents. According to Rouabhia, vapor causes human gingival epithelial cells to alter cell shape from small cuboidal to large and undefined.[38] The cells have a faint nucleus and an enlarged cytoplasm, which can result in altered and impaired function. In vitro studies, such as that by Sunders, have shown that e-cigarettes with flavorings cause increased oxidative/carbonyl stress and inflammatory cytokine (PGE2 and COX-2) release in periodontal ligament fibroblasts.[39] The oxidative stress, pro-inflammatory response, and pro-senescence response leads to dysregulation of repair in periodontal cells, which may contribute to the pathogenesis of periodontal disease. According

to Lerner, e-cigarette aerosols exhibit oxidants/reactive oxygen species reactivity similar to those found in conventional cigarette smoke.[40] There is a dose- and duration-dependent relationship between cigarette smoking and periodontal disease; the more tobacco product used the greater the severity of periodontal disease. However, it is not known if there is a relationship between e-cigarette vaporizing and periodontal disease.

Wadia et al. identified a statistically significant increase in gingival inflammation when tobacco cigarette smokers switched to e-cigarette use for two weeks.[41] Javed et al. reported no difference in plaque index or probing depths, but less gingival bleeding among exclusive e-cigarette users compared to non-smokers.[42] In a recent longitudinal study, Atuegwu et al. examined national (US) data and found that e-cigarette users were more likely to report a gingival disease diagnosis at follow up when compared to non-users. In this study, both tobacco use and gum disease were self-reported.[37]

Within the last decade, the population prevalence of cannabis use has increased steadily, rising from 5.8 percent in 2007 to 8.4 percent in 2014 (a 45% increase). This increase in prevalence of use is hypothesized to be related to the changing perception of harm associated with cannabis and new state policies that allow legal medical and/or recreational use of cannabis products. In 1970 the Controlled Substance Act categorized marijuana has a Schedule 1 drug. Schedule 1 drugs are considered drugs with high potential of abuse and no medical use. In 1996, California became the first state to legalize medical use of marijuana when it passed the Compassionate Use Act. As of 2020, 33 states, including the District of Columbia, have passed medical marijuana for medical/recreational usage. In 2014, according to Momen-Heravi et al., 2.5 million individuals, 12 years of age and older, started using marijuana for the first

time. That amounts to 7000 new marijuana users per day.[43] According to the National Survey on Drug Use and Health by the NIH, in 2018 there was a lifetime prevalence of use of 45.3 in ages 12 or older, 15.4 in ages 12-17, 51.5 in ages 18-25, and 47.8 in ages 26 or older.

Cannabis is reported to be the number one recreational drug used in the US; however, little is known about the long-term effects of cannabis use on periodontal health. Cannabis is derived from the plant cannabis sativa and is composed of 540 compounds. The main cannabinoids are delta 9-tetrahydrocannabinol (THC) and cannabidiol (CBD), but besides these there are over 100 other cannabinoids. THC is known for its psychoactive properties, in addition to being anti-convulsant, anti-inflammatory, and immunosuppressant. THC binds to CB1 and CB2 receptors. CB1 receptors are found in the brain, basal ganglia, and limbic system (hippocampus and the striatum). CB2 receptors are found in the immune system. Synthetic cannabinoids are designed to mimic THC. They bind to cannabinoid type 1 receptors in the brain and produce psychoactive effects similar to THC. Synthetic cannabinoids tend to be more potent and have more adverse effects compared to natural cannabinoids. CBD is a non-psychotropic agent that has low affinity for CB1 and CB2 receptors but acts as an indirect antagonist of the cannabinoid agonists. Cannabis or cannabinoids can be helpful in treating epilepsy, nausea, and vomiting associated with chemotherapy, loss of appetite, and chronic pain. The FDA has not approved the cannabis plant for medical use, but it has approved drugs that contain cannabinoids. An example of such a medication is Epidiolex, which contains cannabidiol and is used to treat seizures and epilepsy.

To the best of our knowledge, no study has yet evaluated how cannabis use effects periodontal treatment outcomes or the effect it has on the quality and quantity of the

subgingival microbiota. Or taken into account the patterns of use of both tobacco and cannabis, even though their simultaneous use is a common practice. In a recent NHANES study, Shariff et al. reported that high frequency recreational users of cannabis are at higher odds of suffering from clinically defined severe periodontitis.[44] This cross-sectional study evaluated the association between self-reported cannabis use and clinically measured periodontitis. In another longitudinal study, Thomson et al. also concluded that cannabis users are more likely to have periodontal disease.[45] Chisini et al showed that cannabis had an effect on both osteoclast and osteoblast activity, leading to increased alveolar bone loss in rats.[46]

Very few studies have evaluated the association between tobacco/cannabis use and periodontal disease in a clinical setting. Given the billions of dollars spent on periodontitis prevention and treatment in the US each year, it is important to understand how the use of such products effect's periodontal health. The electronic health records (EHR), called AxiUm, at the UCSF School of Dentistry has information regarding cannabis and tobacco use, including the type of product being used by the patient. This EHR also contains clinical measures of disease status, the treatment provided, and other relevant demographic information. Review of this EHR data provides a unique opportunity to study the association between tobacco/cannabis use and periodontal disease. The aims of this study are to assess the prevalence of tobacco and cannabis use among patients visiting the UCSF Dental Center between January of 2019 and June of 2020, and to compare the periodontal diagnoses between groups using cigarettes, non-cigarette tobacco products, e-cigarettes, and marijuana, while accounting for demographic confounding factors, such as age, gender, race, ethnicity, and insurance.

MATERIALS AND METHODS

At the UCSF Dental Center practitioners use AxiUm for patient data collection and treatment planning. AxiUm is a HIPAA-compliant system that includes electronic health records (EHR), billing and practice management applications. Within this dental system, a patient's demographics, medical history, dental history, periodontal history, dental treatment plan, and dental treatment rendered is available for providers to access.

Prior to their dental examination, patients complete a UCSF specific demographic and medical questionnaire. The front desk inputs the demographics and contact information into the patient specific AxiUm chart. The demographic information includes age, gender, race, ethnicity, and insurance information. The patient's medical history, surgical history, medical doctor contact information, medications, allergies, tobacco use, recreational drug use, and alcohol consumption are all stored within the EHR, which is entered by the patient's dental practitioner. The dental practitioner can be an advanced education in general dentistry (AEGD) resident, a dental oncology resident, a dental student, a dentist (faculty), an endodontics resident, a graduate periodontics resident, a hygienist, an international student, an oral surgery resident, an orthodontics resident, a pediatrics resident, a prosthodontics resident, a radiologist, or radiology technician.

For the tobacco information tab, the question asked is "Do you use or have you used tobacco (smoking, snuff, chew, bids, e-cigarette/vaping)". The clinician will mark yes or no. If yes is chosen, the provider will need to indicate whether there has been past or current use. If past use is chosen, one has the option of indicating the product or products that were used (bids, chewing tobacco, smoking, snuff, e-cigarette/vaping, hookah, cigars). Once a product is

chosen the provider will need to specify manually (written text) how much of the product was used per day, for how many years, and when the patient stopped. If the patient is a current user, the provider will indicate the product or products that were used (bids, chewing tobacco, smoking, snuff, e-cigarette/vaping, hookah, cigars). Once a product is chosen the provider will need to specify manually (written text) how much of the product was used per day and for how many years.

In this study, we divided tobacco product use into four categories: cigarette, non-cigarette, E-cigarette, and multi product use. Cigarette products included the group smoking from AxiUm. Non-cigarette tobacco products included the groups bids, chewing tobacco, snuff, hookah, and cigars. E-cigarettes included the group e-cigarette/vaping from AxiUm. The multi product group included when more than one product use was checked off in the tobacco information tab on AxiUm.

For the recreational drugs tab, the question asked is “Do you use prescription drugs, street drugs or other substances for recreational purposes like cocaine, ecstasy, heroin, marijuana, methamphetamine, oxytocin?”. The clinician will mark yes or no. If yes is chosen, the provider will need to indicate what product was or is currently being used (cocaine, ecstasy, heroin, marijuana, methamphetamine, oxytocin, other). Once a product is chosen the provider will need to specify manually (written text) the frequency of product usage. For recreation drug use there is no option within the EHR for the provider to indicate current versus past use.

During the dental examination, a patient’s periodontal chart is filled out by their provider. The chart contains probing depth (PD), clinical attachment loss (CAL), bleeding on probing (BOP), distance from gingival margin to CEJ (GM-CEJ), MG-Con, furcation, plaque, and

mobility information. Periodontal charting involves full-mouth probing assessment at six sites per tooth. The assessment of PD, BOP, GM-CEJ, furcation, plaque, and mobility employ direct measurements. CAL, however, utilizes both a direct and an indirect measurement depending on the position of the gingival margin relative to the CEJ. If the gingival margin is coronal to the CEJ the difference of PD and distance from gingival margin to CEJ is calculated for CAL. If the gingival margin is apical to the CEJ, the physical distance from the CEJ to the base of the periodontal pocket is measured to determine CAL. Depending on the provider, when the location of the CEJ is indistinguishable (seen with non-carious cervical lesions, crown margins, restorations, or restoration overhangs), CAL is recorded as 0.

At the end of a clinical examination, the dental provider completes the American Dental Association (ADA) codes, D0120, D0140, D0150, D0170, D0180, D0190, that explain what type of examination was completed. The following codes and their descriptions are noted here: D0120 Periodic oral evaluation - established patient, D0140 Limited oral evaluation - problem focused, D0150 Comprehensive oral evaluation - new or established patient, D0170 Re-evaluation - limited, problem focused (established patient; not post-operative visit), D0180 Comprehensive periodontal evaluation - new or established patient, and D0190 Screening of a patient.

In this study, we defined periodontitis using the 1999 CDC/AAP case definitions, a commonly used classification system for surveillance of periodontitis.[47] Mild periodontitis is defined as ≥2 interproximal sites with AL ≥3 mm, and ≥2 interproximal sites with PD ≥4 mm (not on same tooth) or one site with PD ≥5 mm. Moderate periodontitis is ≥2 interproximal sites with AL ≥4 mm (not on same tooth), or ≥2 interproximal sites with PD ≥5 mm (not on

same tooth). Severe periodontitis is ≥2 interproximal sites with AL ≥6 mm (not on same tooth) and ≥1 interproximal site with PD ≥5 mm. Patients who did not fit into any of these categories are defines as having no periodontitis.

With the aid of the UCSF Dental Center IT Department, we extracted patient data from January 2019 to June 2020.The extracted data fit our inclusion criteria, which included individuals age ≥18 that had dental examinations, D0120, D0140, D0150, D0170, D0180, D0190, completed between January 2019 to June 2020. For all the patients who fit the inclusion criteria, their demographic data, such as age on treatment date, gender, race, ethnicity, and insurance, provider information, tobacco and recreational drug history, and periodontal chart information were extracted. If information about the patient's tobacco and recreational drugs tab history in the EHR was not selected or was left blank, this was indicated in the extracted data set. For the recreational drugs tab in the EHR, only patients where yes was selected for marijuana usage, was the recreational drug history data extracted for analysis.

Dates of completion, provider who completed the periodontal chart, and all information within the chart (PD, CAL, GM-CEJ, MG Con, Furcation, mobility, BOP, plaque, and mobility) were extracted. Periodontal chart information was usually completed on the same day as the general dental examination. However, in clinics where dental students are still learning how to perform a comprehensive oral examination, students spend a few appointments completing an exam and the patient's periodontal chart might be completed a few days or weeks after the general dental examination date.

All data that fit our inclusion criteria, which were 26,849 charts, were extracted and provided as six separate spread sheets. Sheet 1 contained internal AxiUm Patient ID number,

patient chart number, birth date, age on treatment date, gender, race ethnicity, primary language, account type (insurance or cash), treatment date, AxiUm procedure code completed, ADA CDT Code, CDT Code description, provider id, and provider type description. Sheet 2 internal AxiUm Patient ID number, patient chart number, endocrine diseases, adrenal gland diseases, tobacco use, and recreational drug use. For tobacco use information regarding past use, type of product used in the past, current use, and type of product currently being used were all yes (Y), no (N), or blank answers. Amount used, years used, when the patient stopped product use were all written text. Recreational drug use and type of product used were all yes (Y), no (N), or blank answers. Frequency of use was written text. Sheet 3 contained patient AxiUm number, patient chart number, chart date, provider type, and provider type description, exam type, exam description, AxiUm Specific Periodontal patient number, CAL, prognosis, and mobility. Sheet 4 contained patient AxiUm number, patient chart number, chart date, provider type, and provider type description, exam type, exam description, AxiUm Specific Periodontal patient number, plaque, probing depth, and furcation.

Information from the periodontal chart (CAL and probing depth) are presented as six separate values. Each value represents the clinical measurement, tooth number (T value), the Buccal or Lingual of the tooth, and whether it is mesial, direct, or distal location on the tooth (VAL value = 1 (mesial), 2 (direct), 3(distal)). For example, CAL_Buccal_T1_Val1 represents CAL on for tooth #1 on the mesial buccal location of the tooth.

Data were uploaded to Stata/IC where the various spread sheets had to be combined into one data set. First each data set was cleaned and all information that were not necessary to address the aims of the present study and were therefore not assessed or analyzed for the

purposes of this study. After data cleaning, sheet 1 data only contained patient's chart number, birth data, age on treatment data, gender, race, ethnicity, account type, treatment data, AxiUm procedure, provider ID, provider type. Race category was broken down into 6 groups: White, African American, Asian, Multi, Other, Unknown. The Other racial category included individuals who had indicated on their electronic health record that they were a different racial group than White, African American, or Asian. However, it is unknown what their race is because it was never stated.

Sheet 2 data only contained patient's chart number, tobacco history, past tobacco use history (product used, amount used, how many years used, when stopped), current tobacco use history (product used, amount used, and how many years used), marijuana use, and marijuana use frequency. However, past tobacco amount used, past tobacco how many years used, past tobacco when stopped, current tobacco amount using, current tobacco how many years using, and marijuana frequency are manually (written text) inputted into AxiUm. There was too much variation in the text that the data could not be simplified into numerical values which can be processed by STATA. Because of this limitation only past tobacco product use, current tobacco product use, and marijuana use information was kept for each patient. It is also unknown if the marijuana use is current or former because that information was also manually inputted into AxiUm.

Sheet 3 data only contained patient's chart number, chart date, provider description, and CAL information for 6 sites on each tooth. Sheet 4 data only contained patient's chart number, chart date, provider description, and periodontal probing (PD) information for 6 sites on each tooth. After removing all unnecessary patient medical and dental history, within this

patient population, only patients with treatment codes D0120 (Periodic oral evaluation - established patient), D0150 (Comprehensive oral evaluation - new or established patient), and D0180 (Comprehensive periodontal evaluation - new or established patient) were included in the analysis. Of these patients those treated by dental students, dentists (faculty practice), graduate periodontology residents, and international students (a subcategory of dental students) were left for analysis.

Data between all 4 spreadsheets were then merged within STATA to complete the analysis. Originally data were to be merged based on treatment date; however, treatment date and periodontal chart completion date did not always match. This was due to dental students taking multiple visits to complete an examination causing the periodontal chart to be completed on a different date than the exam. Then data were merged based on chart number and provider number. After data processing was complete, 10,773 patients who were seen at the UCSF School of Dentistry for a dental exam fit the inclusion criteria of this study.

STATISTICAL ANALYSIS

Data analysis was performed to ascertain the relationship between use of tobacco (past and present) and/or cannabis products and periodontitis as defined by AAP/CDC definitions. Covariates included age, gender, and insurance. Univariable and multivariable logistic regression analyses were carried out to evaluate the relationship between exposure (tobacco/cannabis use) and outcome (periodontitis). Five models were fit to evaluate such a relationship. Model 1 was a univariable analysis that considered a dichotomous outcome where no or mild disease were grouped vs moderate or severe disease. Model 2 considered the same outcome but also adjusted for known confounders like age, sex, insurance. Model 3 was a

sensitivity analysis where adjusted logistic regression was carried out to evaluate if product use was associated severe periodontitis. In addition to logistic regression, we chose to do an ordered logistic regression because we wanted to look at periodontal disease as a categorical outcome instead of a dichotomous (yes/no) outcome (as seen in logistic regression models). So, model 4 was a univariable analysis using ordered logistic regression which was fit with a multi-level periodontitis variable where it can assume the value of 0- no disease to 4-severe disease. Model 5 was similar to model 4 but was again adjusted for known confounders. All analyses were undertaken using Stata/IC 16.1 (StataCorp. 2019. College Station, TX: StataCorp).

RESULTS

In 2019-2020 a total of 10,773 patients who were seen at the UCSF School of Dentistry for a dental exam fit the inclusion criteria of this study. Patients were stratified by age into nine groups of 10-year intervals. The age range of the patient population was 18-90 years old. Within this population 6.2% of patients were current tobacco users, 12.0% were former tobaccos users, 6.5% were cannabis users, and 2.3% were both tobacco and cannabis users (Table 1).

Within the tobacco user population, 37.9% of the users were female and 62.1% were male. The overall trend of different tobacco product use showed that more users were male. More current and former cigarette users were male than female, 60.4% and 54.6%, respectively (Table 3). Among both men and women who use only tobacco products, the prevalence was greatest in age groups 31-40 and 51-60 (8.2% and 8.1%, respectively) (Table 2). Among the racial groups, individuals using tobacco products were more likely to be in the Other racial

category which accounted for 33.7% of tobacco users (Table 3). Among the various tobacco products current and former cigarette users (33.3%, 39.5%), current non-cigarette users (36.4%), current and former e-cigarette users (54.4%, 40%), and former multi-tobacco product users (42.9%) were White (Table 3); while current multi-tobacco product users and former non-cigarette users (40.6%, 29.8%) were more likely to be Other race. Tobacco users were also more commonly seen to have government insurance (58.3%) rather than private insurance (14.5%) regardless of current use, former use, or product type (Table 3).

Based on the periodontal disease case definition used in this study, patients who fit the inclusion criteria: 22.4% had no periodontal disease, 7.1% had mild periodontal disease, 48.4% had moderate periodontal disease, and 22.2% had severe periodontal disease (Table 4). The analysis was limited to the 8,722 patients with complete data.

Among the tobacco only product users, patients ranged from having mild to moderate to severe periodontal disease. When looking specifically at current tobacco users, 43.8% of cigarette users, 50.9% of non-cigarette users, 54.4% of e-cigarette users, and 40.6% of multi-tobacco product users had moderate periodontal disease. 37.4% of cigarette users, 23.6% of non-cigarette users, 15.8% of e-cigarette users, 31.3% of multi-tobacco product users had severe periodontal disease. When looking at former tobacco users, 49.7% of cigarette users, 53.2% of non-cigarette users, 50.0% of e-cigarette users, 45.2% of multi-tobacco product users had moderate periodontal disease. Of former users, 34.2% of cigarette users, 21.3% of non-cigarette users, 20.0% of e-cigarette users, and 28.6% of multi-tobacco product users had severe periodontal disease.

As seen in Table 6, the crude association (OR) between current cigarette and former cigarette use and periodontal disease was 1.9 (95% CI 1.5-2.4) and 2.3 (95% CI 1.9-2.7), respectively. After adjusting for age, gender, and insurance current and former cigarette users had 1.7x and 1.4x, respectively, the odds of having periodontitis (adjusted OR = 1.7; 95% CI 1.4-2.2 and adjusted OR = 1.4; 95% CI 1.2-1.7, respectively). All other users of tobacco products, both current and former users, did not have statistically significant results. Logistic regression analysis revealed that the only tobacco product that had a statistically significant association with periodontal disease was the cigarette product.

Within the cannabis user population 41.2% of the users were female and 58.8% were male. Users of both cannabis and tobacco were mostly male (60.5%). Among both men and women who use cannabis products or cannabis and tobacco products, the prevalence was greatest in the 21-30 age group (11.1% and 4.8%, respectively) (Table 2). Among racial groups, individuals using cannabis products and cannabis and tobacco products were more likely to be White than any other single racial group category (42.3% and 40.6%, respectively). Cannabis users and cannabis and tobacco users were also more commonly seen to have government insurance (45.5% and 54.6%, respectively) rather than private insurance (Table 3). Due to lack of information in the patient's AxiUm electronic health record, insufficient information was present to determine if cannabis users and both tobacco and cannabis users, were current or former users and what types of products were used. Among cannabis only product users, a majority of patients had moderate periodontitis, 51.8%, and 21.3% had severe periodontal disease. 45.4% of users of both cannabis and tobacco products had moderate periodontal disease and 30.5% had severe periodontal disease.

The crude association (OR) between cannabis and periodontitis was 1.1 (95% CI 0.9-1.3). This result was not statistically significant. However, after adjusting for age, gender, and insurance cannabis users had 1.3x the odds of having periodontitis, which was statistically significant (OR = 1.3; 95% CI 1.0-1.5). Both cannabis and tobacco product use (dual use) were significantly associated with periodontal disease, after adjusting for confounding factors (OR = 1.7; 95% CI 1.2-2.4).

In addition to looking at the association of tobacco and cannabis product use on periodontal disease, a logistic regression analysis was completed to assess whether there was an association between tobacco products, cannabis products, and tobacco and cannabis products and severe periodontal disease. As with the logistic regression analysis for the association of tobacco product use and any periodontal disease, in this model, current cigarette and former cigarette use and its association with severe periodontal disease was the only statistically significant outcome. The crude association (OR) between current cigarette or former cigarette use causing severe periodontal disease, compared to never smokers, was 2.2 (95% CI 1.9-2.7) and 2.1 (95% CI 1.9-2.4), respectively. After adjusting for age, gender, and insurance, current and former cigarette users had 2x the odds as never smokers to have severe periodontal disease (OR = 2.2; 95% CI 1.9-2.7 and OR = 1.5; 95% CI 1.3-1.7, respectively). All other users of tobacco products, both current and former users, did not have statistically significant results. The crude association (OR) between cannabis and severe periodontal disease was not statistically significant (OR = 1.1; 95% CI 0.9-1.3). After adjusting for age, gender, and insurance, cannabis use did not have a statistically significant association with severe periodontal disease with an adjusted OR (aOR = 1.1; 95% CI 0.9-1.4). The odds of severe

periodontal disease among users of both tobacco and cannabis, compared to never smoking, before and after adjusting for confounding factors was statistically significant (OR = 1.7; 95% CI 1.3-2.3 and aOR = 2.4; 95% CI 1.7-3.2, respectively).

Finally, an ordered logistic regression analysis was assessed. This analysis revealed that odds of being in a more severe category of periodontal disease increases with use of tobacco or cannabis products. The crude ordered logistic regression of current cigarette and former cigarette users was 2.2x for being in a more severe category of periodontal disease (95% CI 1.8-2.5) and 2.2 (95% CI 1.9-2.4), respectively. These results were statistically significant. After adjusting for covariates current and former cigarette users had 2x greater odds of being in a more severe category of periodontal disease than never smokers (adjusted OR = 2.1; 95% CI 1.8-2.4 and adjusted OR = 1.5; 95% CI 1.3-1.7, respectively). All other users of tobacco products, both current and former users, did not have statistically significant results. The crude ordered logistic regression between cannabis and periodontitis was 1.1 (95% CI 1.0-1.3). However, after adjusting for age, gender, and insurance cannabis users had 1.2x greater odds than never smokers of being a more severe category of periodontal disease (adjusted OR = 1.2; 95% CI 1.1-1.4). This association was statistically significant. The odds being at a higher severity level of periodontal disease were higher and statistically significant among users of both tobacco and cannabis (crude OR = 1.6; 95% CI 1.3-2.1 and adjusted OR = 2.1; 95% CI 1.6-2.7).

TABLE 1: PREVALENCE OF USE OF TOBACCO AND CANNABIS AMONG UCSF PATIENT POPULATION

				Gender		Race						Insurance		
		N	Prev. (%)	F (%)	M (%)	White (%)	A.A (%)	Asian (%)	Multi (%)	Other (%)	Unknown (%)	None (%)	Govt. (%)	Priv. (%)
Never User		7,104	65.9	39.3	26.5	15.5	4.2	10.5	6.4	27.2	2.2	19.1	26.3	20.5
Tobacco Only														
	Current Tobacco	664	11.9	2.3	3.8	2.0	0.8	0.6	0.5	2.1	0.3	1.7	3.6	0.9
	Former Tobacco	1,288	12.0	5.2	6.7	4.5	0.9	1.3	0.9	3.9	0.4	4.5	4.8	2.6
Cannabis Only		705	6.5	2.7	3.8	2.8	0.9	0.3	0.4	2.0	0.3	2.2	3.0	1.3
Both		249	2.3	0.9	1.4	0.9	0.3	0.1	0.1	0.7	0.1	0.8	1.3	0.3
Missing		2,051	7.08	3.7	3.4	1.1	0.3	0.5	0.3	4.5	1.1	1.6	1.4	4.1
N		10,773		5,828	4,923	2,894	797	1,418	925	4,338	401	3,214	4,356	3,203

TABLE 2: DEMOGRAPHIC INFORMATION OF UCSF PATIENTS USING TOBACCO AND CANNABIS (AGE)

	Mean Age	Standard Deviation	Min Age	Max Age	18-20 (%)	21-30 (%)	31-40 (%)	41-50 (%)	51-60 (%)	61-70 (%)	71-80 (%)	81-90 (%)	>90 (%)
Never User	51.5	18.0	18	95	79.0	68.1	66.8	67.4	63.9	63.3	65.3	66.9	83.3
Tobacco Only	48.3	15.6	18	88	5.5	6.3	**8.2**	6.7	**8.1**	5.0	3.4	1.8	0
Cannabis Only	46.1	16.0	18	85	8.2	**11.1**	7.4	6.5	6.4	6.0	3.4	0.8	0
Both	41.2	15.0	18	75	3.7	**4.8**	3.7	2.4	1.5	1.9	0.3	0.0	0
Missing	57.6	16.3	18	95	3.7	9.6	14.0	17.1	20.2	23.9	27.7	30.5	16.7

TABLE 3: DEMOGRAPHIC INFORMATION OF UCSF PATIENTS USING TOBACCO AND CANNABIS (GENDER, RACE, INSURANCE)

			Gender		Race						Insurance		
			F (%)	M (%)	White (%)	A.A (%)	Asian (%)	Multi (%)	Other (%)	Unknown (%)	None (%)	Govt. (%)	Private (%)
Never User			59.7	40.3	23.6	6.4	15.9	9.7	41.2	3.3	28.9	39.9	31.1
Tobacco Only			37.9	**62.1**	31.9	12.8	9.0	8.4	**33.7**	4.1	27.3	**58.3**	14.5
	Current Tobacco	**Cigarette**	39.6	60.4	**33.3**	13.8	8.2	7.9	31.9	4.9	28.6	57.7	13.7
		Non-Cigarette	34.6	65.5	**36.4**	14.6	5.5	3.6	32.7	7.3	25.5	65.5	9.1
		E-Cigarette	40.0	60.0	**54.4**	7.0	7.0	7.0	24.6	0.0	26.3	63.2	10.5
		Multi	21.9	78.1	31.3	9.4	6.3	9.4	**40.6**	3.1	31.3	56.3	12.5
	Former Tobacco	**Cigarette**	45.4	54.6	**39.5**	7.3	9.5	7.5	32.5	3.8	37.7	40.9	21.4
		Non-Cigarette	23.4	76.6	27.7	19.2	12.8	4.3	**29.8**	6.4	31.9	38.3	29.8
		E-Cigarette	11.1	88.9	**40.0**	0.0	20.0	10.0	30.0	0.0	30.0	60.0	10.0
		Multi	19.1	81.0	**42.9**	14.3	7.1	0.0	31.0	4.8	40.5	33.3	26.2
Cannabis Only			41.2	**58.8**	**42.3**	13.3	4.0	5.8	30.4	4.3	33.9	**45.5**	20.6
Both			39.5	**60.5**	**40.6**	13.3	4.4	6.0	29.7	6.0	32.9	**54.6**	12.5

TABLE 4: PREVALENCE OF PERIODONTAL DISEASE AMONG UCSF PATIENT POPULATION

	No Disease	Mild Disease	Moderate Disease	Severe Disease
%	22.4	7.1	48.4	22.2
N	2,782	882	6,014	2,756

TABLE 5: PREVALENCE OF PERIODONTAL DISEASE AMONG TOBACCO AND CANNABIS USERS

			No Disease	Mild Disease	Moderate Disease	Severe Disease	N
Never User (%)			21.3	7.9	**50.0**	20.7	7,104
Tobacco Only							
	Current Tobacco	**Cigarette**	9.5	8.8	**43.8**	37.4	672
		Non-Cigarette	12.7	12.7	**50.9**	23.6	55
		E-Cigarette	14.0	15.8	**54.4**	15.8	57
		Multi	15.6	12.5	**40.6**	31.3	32
	Former Tobacco	**Cigarette**	10.6	5.5	**49.7**	34.2	1,502
		Non-Cigarette	21.3	4.3	**53.2**	21.3	47
		E-Cigarette	20.0	10.0	**50.0**	20.0	10
		Multi	23.8	2.4	**45.2**	28.6	42
Cannabis Only (%)			15.9	11.1	**51.8**	21.3	705
Both (%)			9.2	11.2	**45.4**	30.5	249
Missing (%)			18.0	4.9	**47.6**	29.4	2,051

TABLE 6: PREVALENCE ODDS AND ADJUSTED ODDS RATIOS OF PERIODONTITIS AMONG TOBACCO AND CANNABIS USERS (ALL PERIO DISEASE)

		Odds Ratio (95% CI)	P > |z|	Adjusted Odds Ratio (95% CI)	P > |z|
Current Tobacco	**Cigarette**	**1.9 (1.5, 2.4)**	**0.0**	**1.7 (1.4, 2.2)**	**0.0**
	Non-Cigarette	1.2 (0.6, 2.3)	0.6	1.2 (0.6, 2.4)	0.6
	E-Cigarette	1.3 (0.6, 3.0)	0.5	1.4 (0.6, 3.2)	0.5
	Multi	1.2 (0.4, 3.4)	0.7	1.5 (0.5, 4.4)	0.5
Former Tobacco	**Cigarette**	**2.3 (1.9, 2.7)**	**0.0**	**1.4 (1.2, 1.7)**	**0.0**
	Non-Cigarette	1.2 (0.6, 2.4)	0.6	1.1 (0.5, 2.2)	0.9
	E-Cigarette	0.8 (0.2, 3.3)	0.8	1.6 (0.3, 8.1)	0.6
	Multi	1.4 (0.6, 3.3)	0.4	1.3 (0.5, 3.4)	0.5
	Cannabis	**1.1 (0.9, 1.3)**	**0.2**	**1.3 (1.0, 1.5)**	**0.0**
	Cannabis and Tobacco	**1.3 (1.0, 1.8)**	**0.1**	**1.7 (1.2, 2.4)**	**0.3**
	Age			1.1 (1.0, 1.1)	0.0
	Gender			1.7 (1.5, 1.8)	0.0
Insurance	**Government**			1.2 (1.1, 1.3)	0.0
	Private			0.5 (0.4, 0.6)	0.0

TABLE 7: PREVALENCE ODDS AND ADJUSTED ODDS RATIOS OF PERIODONTITIS AMONG TOBACCO AND CANNABIS USERS (SEVERE PERIO DISEASE)

		Odds Ratio (95% CI)	P > |z|	Adjusted Odds Ratio (95% CI)	P > |z|
Current Tobacco	**Cigarette**	**2.2 (1.9, 2.7)**	**0.0**	**2.2 (1.9, 2.7)**	**0.0**
	Non-Cigarette	1.2 (0.6, 2.4)	0.6	1.3 (0.6, 2.7)	0.5
	E-Cigarette	1.0 (0.4, 2.3)	1.0	1.1 (0.5, 2.6)	0.8
	Multi	2.1 (0.8, 5.2)	0.1	2.5 (0.9, 6.6)	0.1
Former Tobacco	**Cigarette**	**2.1 (1.9, 2.4)**	**0.0**	**1.5 (1.3, 1.7)**	**0.0**
	Non-Cigarette	1.0 (0.5, 2.1)	1.0	0.8 (0.4, 1.9)	0.7
	E-Cigarette	0.5 (0.1, 3.8)	0.5	0.8 (0.1, 6.5)	0.8
	Multi	1.8 (0.9, 3.9)	0.1	1.8 (0.8, 4.1)	0.1
	Cannabis	**1.1 (0.9, 1.3)**	**0.6**	**1.1 (0.9, 1.4)**	**0.2**
	Cannabis and Tobacco	**1.7 (1.3, 2.3)**	**0.0**	**2.4 (1.7, 3.2)**	**0.0**
	Age			1.0 (1.0, 1.0)	0.0
	Gender			1.5 (1.4, 1.7)	0.0
Insurance	**Government**			1.2 (1.1, 1.4)	0.0
	Private			0.5 (0.5, 0.6)	0.0

TABLE 8: PREVALENCE ORDERD AND ADJUSTED ORDERED LOGISTICS ODDS RATIOS OF PERIODONTITIS AMONG TOBACCO AND CANNABIS USERS (ALL PERIO DISEASE)

		Odds Ratio (95% CI)	P > |z|	Adjusted Odds Ratio (95% CI)	P > |z|
Current Tobacco	**Cigarette**	**2.2 (1.8, 2.5)**	**0.0**	**2.1 (1.8, 2.4)**	**0.0**
	Non-Cigarette	1.2 (0.7, 2.1)	0.5	1.3 (0.7, 2.2)	0.4
	E-Cigarette	1.2 (0.7, 2.3)	0.5	1.2 (0.6, 2.3)	0.5
	Multi	1.8 (0.8, 4.1)	0.2	2.1 (0.9, 5.0)	0.1
Former Tobacco	**Cigarette**	**2.2 (1.9, 2.4)**	**0.0**	**1.5 (1.3, 1.7)**	**0.0**
	Non-Cigarette	1.1 (0.6, 1.9)	0.8	0.9 (0.5, 1.6)	0.8
	E-Cigarette	0.7 (0.2, 2.4)	0.6	1.1 (0.3, 4.0)	0.9
	Multi	1.6 (0.8, 3.1)	0.2	1.4 (0.7, 2.8)	0.4
	Cannabis	**1.1 (1.0, 1.3)**	**0.1**	**1.2 (1.1,1.4)**	**0.0**
	Cannabis and Tobacco	**1.6 (1.3, 2.1)**	**0.0**	**2.1 (1.6, 2.7)**	**0.0**
	Age			1.0 (1.0, 1.0)	0.0
	Gender			1.6 (1.5, 1.7)	0.0
Insurance	**Government**			1.2 (1.1, 1.3)	0.0
	Private			0.5 (0.4, 0.5)	0.0

DISCUSSION

The present investigation was undertaken to evaluate the potential influence of tobacco and cannabis use on the periodontal health of patients in the UCSF School of Dentistry population. As such, the results of this study represent only this particular sample and cannot be extrapolated to the general population.

The main outcome measures were periodontal pocketing and clinical attachment level. These measurements were based on full-mouth examinations that were completed by dental students, periodontal residents, or faculty practice dentists. The present observations show a significantly greater frequency of periodontal disease in current tobacco smokers compared to never smokers and current tobacco and cannabis smokers compared to never smokers. These observations suggest a negative impact of tobacco and tobacco and cannabis products on periodontal health.

The multivariable regression model suggests that tobacco exposure, specifically cigarette products, are a major predictor of periodontal disease after adjusting for age, gender,

and insurance. Tobacco was also found to be associated with worse periodontal health among cannabis smokers. Regardless of being a current or former user, cigarette smoking had a positive association with periodontal disease. Current cigarette smokers had an adjusted odds ratio of 1.7 and former cigarette smokers have an adjusted odds ratio of 1.4 of having periodontal disease. The odds of having severe periodontal disease in tobacco users compared to non-users was 2.2 for current cigarette users and 1.5 for former cigarette users. The odds of having more severe periodontal disease with increased use of a tobacco product compared to non-users was 2.1 for current cigarette users and 1.5 for former cigarette users. The data support previous reports indicating a strong association between smoking and periodontal disease.[48,49] Published works, such as Tomar and Asma have shown that current smokers are 4 times as likely and formers smokers are 2 times as likely as never smokers to develop periodontal disease.[21] In addition, Jamieson et al found that there was elevated risk of periodontal disease associated with a tobacco prevalence ratio of 1.59.[50]

The findings of our study also show that former smokers are less likely than current smokers to have periodontitis. Similarly, Haber and Kent found that the prevalence of periodontal disease decreased from current smokers to former smokers to never smokers; current smoking versus never smoking had an odds ratio of 3.3 and former smoking versus never smoking had an odds ratio of 2.1.[49] Unfortunately, because our study is a cross-sectional study, we could not directly estimate change in risk after quitting for former users unlike other studies.

The association between cigarette use and periodontal disease in our study is generally consistent with findings from other cross-sectional epidemiological studies.[51] According to

Norderyd, heavy smoking was associated with severe periodontal destruction with an odds ratio of 9.78.[51] However, in that study they were able to delineate if patients were heavy, moderate, or light smokers. Unfortunately, due to medical history questionnaire constraints we were not able to analyze the effect of the amount of smoking on periodontal health.[49]

All other tobacco products did not have a statistically significant association. The reason for the lack of association could be due to the small sample size value for the various non-cigarette tobacco product groups. In our dataset, there was a total of 47 former non-cigarette users, 10 former e-cigarette users, 42 former multi-tobacco product users, 55 current non-cigarette tobacco users, 57 current e-cigarette users, and 32 current multiple tobacco product users. Out of 10,773 patients these N values per group are minimal resulting in statistically insignificant results.

For cannabis use, the results of this study showed 1.3 times greater odds of having periodontal disease compared to a never user. And the odds of having more severe periodontal disease with increased use of cannabis compared to non-users was 1.2. These results are in agreement with Shariff et al. who showed that frequent cannabis users were twice as likely as never users to have inferior periodontal status.[44] Thomson et al found that after controlling for tobacco smoking and confounders, regular exposure to cannabis smoke was strongly associated with the prevalence and incidence of periodontal attachment loss with a 2.15 relative risk of developing periodontal disease in the highest cannabis exposure group.[45] Lopez et al, however, found that there was no evidence to suggest the use of cannabis is positively associated with periodontal disease in an adolescent population.[52] Compared to previously published studies, cannabis use in this study has a weaker association with periodontal disease (lower ORs). A

reason for these findings could be that at UCSF Dental Center patients are not reporting their use of cannabis products or providers are not asking the appropriate questions about the patient's recreational drug history. More users could have been categorized as non-cannabis users therefore resulting in smaller odds ratios.

Both cannabis and tobacco users have 2.4 times greater odds of having severe periodontal disease compared to never users and 2.1 times greater odds of having more severe periodontal disease with increased use of tobacco and cannabis compared to non-users. Current cigarette smokers had an adjusted odds ratio of 1.7. In this study, the odds ratio of tobacco and cannabis use (OR 2.4) is similar to that of current cigarette use or former cigarette use alone (OR 1.7, 1.4 respectively). Therefore, in this patient population cannabis has a modest association with periodontal disease among tobacco users.

LIMITATIONS

Several limitations of this study should be considered when interpreting the findings. First, excluding patients with incomplete medical or social history and patients not treated by dental students, graduate periodontal residents, or faculty practice dentists, may have introduced a selection bias. Dental students, graduate periodontal residents, and faculty practice dentists were chosen as the primary providers, because they are the ones that primarily complete a comprehensive oral evaluation at the UCSF Dental center. When they complete periodontal charting, all values within the chart are filled out, unlike with other providers where a quick evaluation and sometimes no periodontal chart are completed.

Second, the data were derived from a cross-sectional survey, so it cannot be determined whether the exposure to tobacco and cannabis products preceded the onset of disease. In

addition, one cannot differentiate periodontal sites with active disease from those with longstanding periodontal pockets or clinical attachment loss due to trauma, habits, or congenitally acquired. With the current case definition of periodontal disease, using 6 sites on teeth, including mid buccal and mid lingual, there is an overestimation of the incidence of periodontal disease in the patient population. Measurements on midbuccal and midlingual might represent clinical attachment loss due to vigorous toothbrushing rather than from periodontal disease. Due to lack of periodontal history and radiographic findings, conclusions regarding the etiology of clinical attachment loss and periodontal probings could not be made. It was assumed that all deep probings and clinical attachment loss were due to periodontal disease.

A third limitation of this study is that tobacco and cannabis use was based on patient self-reporting. Self-reported data can lead to underreporting of substance use patterns, systemic conditions, and other medical information owing to recall and social bias[44]. In addition, input of the patient's social history into AxiUm is based on the provider's discretion. Patients fill out a medical and social history questionnaire prior to their comprehensive exam. Sometimes the provider may not input all the information from the questionnaire into the patient's chart resulting in incomplete social history. This is commonly seen with dental students who are still learning how to use the AxiUm system.

To date, many studies on cannabis use and its effect on the periodontium have not been able to quantify the amount of cannabis used by patients. The gold standard for recording drug consumption is a laboratory test; however, these tests are both time consuming and expensive. In this study, patient self-reporting was utilized, which introduces an inherent error of biased.

Due to this flaw in study design, currently it was not possible the determine the effect of quantity of cannabis use and its effect on the periodontium.

Another inherent error noted was the questionnaire that was provided to patients. This questionnaire did not have an area for patients to appropriately indicate their race or ethnicity. The health questionnaire only included preset race, ethnicity, and nationality information for patients to choose from. Although, there was an option for individuals to indicate “other” and write in their answer, many patients did not report their response. Unfortunately, due to the variability in patient’s indicating their race versus their nationality, we were not able to analyze how tobacco and cannabis usage varied among racial groups.

When it comes to social history (tobacco and cannabis use), patients did not have the ability to check off boxes indicating how much they smoke or for how long, they had to write in their responses. For example, a patient would check off that they were a past tobacco user that used cigarettes, but they would need to manually write in how long ago they quit instead of checking off a box that said quit <1 year ago, between 1-11 years ago, or >11 years ago. In the area of cannabis, patients only had one box to write out what product they were using, for how long they used it, and so on. Often the patient would say they used cannabis but did not provide any further information. Due to this discrepancy in filling out the health questionnaire, a lot of data could not be collected and analyzed. We were unable to make an association between how much of the product was used and severity of the disease, how long the product had been used and the severity of the disease, and how long since quitting was there still an effect on the severity of disease.

Finally, there is a variability in periodontal probing between dental students, graduate periodontal residents, and faculty dentists.[53] None of the clinicians probings were calibrated and therefore there was variability between clinicians. More experienced clinicians have more accurate and reproducible periodontal probings and clinical attachment measurements. When given the opportunity, if a patient was seen by a dental student and a periodontal resident, the periodontal resident's exam information was recorded.

Some strengths of the study include the large sample size of over 10,000 individuals, compared to previously published studies that might have only analyzed data of a few hundred patients. Having access to dental school records allowed us to analyze these thousands of individuals. In the future if further analysis were to be completed over a larger sampled time frame, there would be an even greater N to study from with more data to analyze, including gathering more information on tobacco and cannabis products that were underreported in this study. In addition, this would also allow us to follow our patient population over an extended period to gather information on changes in tobacco and cannabis product use and changes in their periodontal history.

In addition, through AxiUm we have access to patient history. If we were able to analyze written text in the patient's dental notes, we could analyze more specifics about the product used and for how long they used it, information that providers sometimes divulge in patient exam notes, but not in the EHR. With these data we would be able to fill the gaps in this present study such as if there is a dose-dependent interaction between product and periodontal disease, former versus current cannabis use and its effect on periodontal disease, and how different types of cannabis products effect disease prevalence. However, the current

limitation is being able to convert this textual data into numerical values that can be easily analyzed.

CONCLUSION

Within this population of northern California patients attending an academic school dental practice, 6.2% of patients were current tobacco users, 12.0% were former tobaccos users, 6.5% were cannabis users, and 2.3% were both tobacco and cannabis users. This comprised a significant portion of our patient population, making use of such substances a relevant consideration for periodontal providers.

The study found an association between using tobacco and using both tobacco and cannabis products and having periodontal disease. Tobacco use, with and without cannabis use, was strongly associated with periodontitis. In addition, the results of this study showed that cannabis use alone was associated with periodontitis, but not severe periodontal disease.

With the recent legalization of medical and recreational cannabis use, there will likely be an increase in prevalence of cannabis use throughout the United States. It is important for health care clinicians to understand its potential risks. Determining whether an association exists between cannabis and periodontal disease should be a priority for periodontal epidemiological studies. Dental and medical practitioners should take steps to raise awareness of the possibility of regular cannabis use as a potential risk factor for periodontal disease.

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